Small Business Innovation Research/Small Business Tech Transfer

Satellite Swarm Localization and Control via Random Finite Set Statistics, Phase I

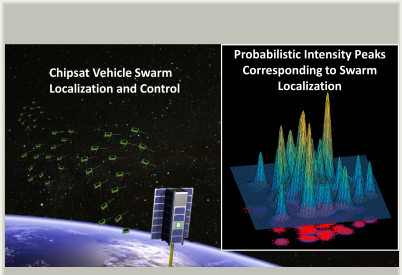
Completed Technology Project (2016 - 2017)

Project Introduction

The proposed novel program will develop and demonstrate a new approach to perform real-time relative vehicle localization within a swarm formation with application to communication-less coordination. These objectives are achieved by using Random Finite Sets statistics theory to solve the multiple object tracking problem. The swarm formation localization problem can be formulated as estimating the local intensity function of targets in the near field and developing probabilistic control strategies to track an expected localization state space configuration. Work will focus on developing estimation and control algorithms that can utilize simple measurements range and bearing angle to other units, and also determine the local environment using feature measurements. Three major tasks are proposed for the development of swarming space vehicle estimation and control: Random Finite Set Localization, Random Finite Set Formation Control, and Bayesian Collective Decision Making. Algorithm development in Phase I will extend to a Hypothesis Density Filter and Sequential Monte Carlo Hypothesis Density Filter, Motion Model, Estimation techniques, Landmark SLAM using these techniques, Behavioral Distribution Control, Cyclic Distribution Control, and multiple decision making estimation models. Proposed follow-on efforts will fully implement the swarm technology for real-time integrated system use, identify different formation configurations and sensor combination for hardware integration, and work to position the system for integration into a demonstration mission identified in the Phase I work to fully illustrate the mission enhancements of the operational system.

Anticipated Benefits

NASA applications consist of enabling autonomous precision swarm coordination for satellites traveling in Earth orbit or eventually into deep space, including greater precision for vehicle control. The swarm formation coordination and control algorithms and software will provide expanded mission planning and analysis capabilities, reduction of communication requirements, and reduction of mission risk. The system would offer significant value in providing or augmenting current navigation and control technologies and techniques, as well as reduce support costs and system station-keeping down-time. The system can also offer precise formation control for assisting multiple spacecraft formation flying anywhere in the solar system. The proposed system data product has potential to enable benefits to autonomous planetary rover swarms, asteroid and comet exploration, and earth orbiting swarms.Non-NASA applications for this technology include increased coordination and control for units of multiple unmanned aerial systems performing search and rescue operations, for the Department of Homeland Security and other government agencies or local municipalities. Robotic or autonomous land, sea, and air vehicle coordination for the Department of Defense, and reduction of communication and relay requirements is an added application. Commercial telecommunication satellite providers that desire to



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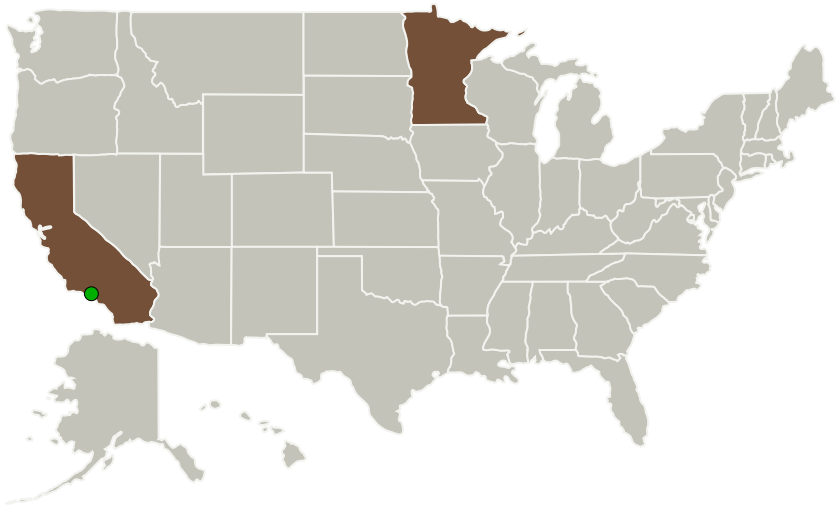
transmit large data rate information between multiple vehicles, such as imaging or internet-like inter-satellite networks, could realize the formation control benefits through this enabling technology.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
ASTER Labs, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Shoreview, Minnesota
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California
University of Minnesota-Twin Cities	Supporting Organization	Academia	Minneapolis, Minnesota

Primary U.S. Work Locations	
California	Minnesota

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

ASTER Labs, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Robert A Jones
Carol R Lewis

Principal Investigator:

Suneel I Sheikh

Co-Investigator:

Suneel Sheikh

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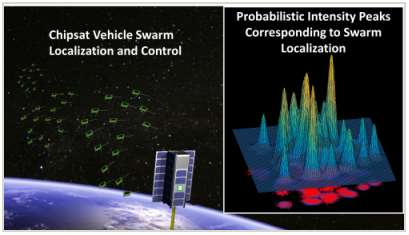
Images



Briefing Chart Image
Satellite Swarm Localization and Control via Random Finite Set Statistics, Phase I
(https://techport.nasa.gov/image/135378)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**